

Cruise Report – RV Ocean Veritas Sept. 19 - Oct. 9, 2010



Summary

A sampling cruise to assess the magnitude and extent of oil residues in sediment, and possible biological impacts, in the Gulf of Mexico following the Deepwater Horizon spill was conducted on the chartered vessel RV Ocean Veritas. The first leg of the cruise took place from Sept. 19 - Oct. 9. Sediment samples were collected at 42 locations on transects radiating out from the well head from depths of 1520m to 22m. Sediment and water samples were collected for chemical analyses, biological assessment, and toxicity. In the vicinity of the well a pronounced floc layer of unknown composition overlaid the bottom. The thickness of the layer decreased with distance from the well. Laboratory analyses of the material is ongoing. A second and third leg of the cruise to sample sediment along the continental slope east and west of the well, were initiated immediately following the cruise summarized below.

Background

As laid out in the National Incident Commander's Directive of 13 Aug 2010 the goals of the Implementation Plan for Sub-Sea and Sub-Surface and Dispersant Detection, Sampling and Monitoring Strategy dated 3 Sept., were to:

- 1) Monitor and assess the distribution, concentration, and degradation of the portion of the oil that remains in the water column and/or bottom sediments.
- 2) Evaluate the distribution of indicators of dispersant or break-down products of dispersants used in oil spill response activities.
- 3) Identify any additional response requirements that may be necessary to address remaining sub-surface oil.

A large amount of water column data was collected in the near shore and off shore domains to locate any oil and/or dispersant, and their potential break-down products from the Deepwater Horizon (DWH) oil spill. The deep water column was extensively sampled within 30 km of the source using fluorometry, particle analyzers, oxygen probes, hydrocarbon analyses and standard conductivity, temperature, and depth (CTD) sensor casts. Additional water and sediment samples were concentrated in the near shore environments. In the deep water environment (beyond the continental shelf break), the data shows that dispersant applied at the well head on the sea floor was effective in chemically dispersing some of the source oil. While the well remained

uncapped, indications of a layer of diffuse hydrocarbons in the 1000m-1300m depth range were reported consistently by numerous sampling teams. These signals were also consistently modeled and observed southwest of the source. After the well was capped, the deep water hydrocarbon signature degraded.

There are several possible ways for oil to be entrained in sediment including, but not limited to:

- 1) Oil mixing with and adsorbing to drilling muds injected into the leaking well during Top Kill efforts;
- 2) Adsorption of oil to suspended sediment discharged from the Mississippi River that subsequently settles into sediment layers;
- 3) Microbial cells, enriched when degrading the oil, subsequently settle to the bottom and;
- 4) Residual material generated by controlled burns on the surface.

Consequently, a sediment sampling program was initiated to assess whether any sediment oiling has occurred;

- 1) near the wellhead where there will be localized settling of drilling muds and;
- 2) on the shelf in bottom areas corresponding to locations of surface oil burns, aerial dispersant applications, and
- 3) heavily oiled shore areas (tar balls, oil mats, and oiled beaches and marshes).

The purpose of this cruise was to begin to assess the presence or absence of oil residuals in the sediment on the continental shelf, slope, and deep ocean in the Gulf of Mexico.

Objectives

Assessment of the presence of oiled sediment in the region between the deep water source and the beaches were to be evaluated with this cruise. Corridors from the source well to the shorelines that experienced the heaviest oiling were identified (Fig. 1). These originated at the well head, pass beneath areas where dispersants have been applied and surface burns have occurred, and meet the shoreline. The axes of these corridors were identified as meeting the shoreline at Barataria Bay, Garden Island Bay, the Chandeleur Barrier Islands, and Petis Bois Island, AL. A second ship (RV Gyre) was to collect sediment cores around the annulus of the well, starting as close to the well head as allowed.

Activities

1. Sampling Plans

- 1.1. As originally planned, the cruise was to be conducted on the NOAA ship Ron Brown. Initial staging was to take place in Charleston, SC, followed by a transit to the Gulf of Mexico beginning on September 11. Sampling would continue through Sept, 25. Sampling objectives included sediment and water collections, CTD casts including routine water quality parameters plus fluorometry, and Microtox testing for sediment and water. Water samples were to be taken for hydrocarbon analysis. Sediment samples were to be taken for hydrocarbons and dispersant marker analyses. Additional sediment samples were to be taken for macrofauna and meiofauna assessment. Sediment sampling was to be carried out with a multicorer; a device that is designed to collect 8-12 discrete core samples at once (Fig. 2). Up to 15 academic scientists were to be accommodated but their role was not initially defined.

- 1.2. Prior to sailing, the ship platform was changed from the RV Ron Brown to the RV Ocean Veritas, a BP chartered vessel that had been operating in the Gulf all summer. The sailing dates were changed from 9/11-9/25 to 9/18-10/9. A parallel cruise on the RV Gyre (another BP charter vessel) with similar sampling gear and objectives, but with a different sampling strategy was planned as an advanced shakedown cruise to refine sampling procedures. From this time forward, the cruise plan, objectives, chemical analyses, personnel, onboard equipment, analytical labs, numbers of samples, and proposed sampling sites changed on an almost daily basis as BP and the Subsurface Monitoring Unit (SMU) negotiated the sampling program. All the gear that had been mobilized in Charleston was redirected first to Pascagoula, MS, and then to Prairieville, LA for mobilization at Morgan City, LA, where the RV Ocean Veritas was in port undergoing extensive renovations to accommodate a sediment sampling program. All personnel contracts and travel arrangements were changed.

2. Implementation

- 2.1. Sept 17- Arrived in New Orleans, linked up with half of NOAA crew and met with SMU support team. Met with BP and NOAA representatives to discuss sampling priorities and procedures. Still debating priorities. BP's number one priority is to do onboard GC/MS analysis of sediment samples for PAHs. In addition, samples for onshore analysis of hydrocarbons, metals, BTEX, plus grain size and TOC/TIC samples will be taken. Onboard toxicity (Microtox), macrofauna, meiofauna, samples are of secondary priority. Various options and possible support sampling by other USGS and/or NOAA ships in the vicinity were discussed. In the event significant PAHs are found, a 'step-out' procedure to circle the sampling site with additional samples is to be initiated, but this will require a section 106 (archeological site assessment) review which will take at least 24 hrs. The ship does not have a fluorometer or Microtox unit yet. The multicorer will require its own winch which has not been delivered to the ship and it will not be operational before Sunday 9/19.

Brian Critchley (BP chief scientist on RV Gyre) reviewed the single deployment attempt of the multicorer unit on the RV Gyre. A variety of operational difficulties were identified. The basic operation is to collect the cores, randomize them for each specific analysis (e.g. PAHs, macrofauna, toxicity), extrude the top layer(s) of sediment for collection and preservation. He will sail on the RV Ocean Veritas for the first leg of the cruise and the RV Gyre will sail with an alternate Chief Scientist. The Cruise Plan SOP for the Ocean Veritas will be a clone from the Gyre, but it is not yet available.

- 2.2. Sept 18 – Inspected RV Ocean Veritas in Morgan City, LA. Analytical lab had been installed on fantail deck. Some NOAA gear has been delivered from Prairieville by Shaw Grp. (BP consultant). The whereabouts of the rest is unknown. The winch for the multicorer had not been delivered to the ship. A water filtration unit needed for processing meiofauna samples, the Microtox unit, the fluorometer, critical components for the GC/MS, and a variety of miscellaneous items had not been delivered by Shaw Grp. The cruise plan SOP from the RV Gyre had not been completed.
- 2.3. Sept 19 – Ship is still not ready to sail. Missing NOAA gear is delivered. Unpacking and organizing sampling gear is initiated. Construction of sample handling area on fantail, and winch installation proceeds. An extensive data management meeting was conducted at the UAC to work out final details of protocols, which are different

from what had been required for water sampling in previous cruises. The cruise plan SOP from the RV Gyre had not been completed.

- 2.4. Sept 20 - Ship is still not ready to sail. A water filtration unit needed for meiofauna samples, the fluorometer, and critical components for the GC/MS, had not been delivered. The cruise plan SOP from the RV Gyre has not been completed. The Microtox unit arrived but the bacterial cultures were not frozen after being delivered to the ship. A PR event for local news outlets was conducted including comments by Adm. Zukunft, Janet Baren and the chief scientist, followed by questions from the media. Began practice dry runs to organize crew and sample handling procedures. Entrix personnel (BP consultants) are unwilling to cooperate with sampling, processing, or chain of custody for any sample other than chemical samples for onshore analysis despite BP's instructions to the contrary. This will prove to be a continuous problem. The cruise plan SOP from the RV Gyre had not been completed.
- 2.5. Sept 21 - Ship is still not ready to sail. A water filtration unit needed for meiofauna samples, the fluorometer, and critical components for the GC/MS, have not been delivered by Shaw Grp. The cruise plan SOP from the RV Gyre had not been completed. Purchases at local hardware and a lab supply outlet will allow us to improvise for sampling operations until ordered supplies arrive.
- 2.6. Sept 22 - Left dock at 1100hrs. Will take 10-12 hrs to reach 1000m depth range to calibrate the Ultra-Short Baseline (USBL) system for tracking the position of the multicorer rig with respect to the vessel. The multicorer rig was fitted with a transponder that responds to the USBL system's pole-mounted transducer's interrogations. The pole-mounted transducer then translates the acoustic responses from the transponder to calculate its current position to within a few meters. The calibration of the transducers is supposed to take 8-12 hrs. On the way out, the crew drills for sample handling procedures. The most efficient approach is to have them operate in platoons to handle core extrusions for each sample analyte (see photos Figs. 3 & 4). The cruise plan SOP from the RV Gyre had not been completed. During the transit, seas come up to 6' which was too rough to calibrate the USBL.
- 2.7. Sept 23 - Waited for weather to calm. Decided to go back inshore to beginning of westernmost transect to begin sampling in shallow water where USBL is of little consequence.
- 2.8. Sept 24 - On station 1.20 at 0700hrs. Sampled stations 1.20, 19, and 18 with only minor equipment problems. GC/MS and Microtox samples are archived at all stations. At station 1.18, the line fell off the block wheel on the A frame and got caught in between the wheel and the block housing. Ship's crew had to rig a Bosun's chair to hoist a man up to clear the block, and replace it with a different block. Then the aft A frame developed a hydraulic fluid leak and a rain squall came up suddenly, so sampling operations were terminated for the day. Prepared for sampling the following day and compiled needs for a supply shipment at Port Fourchon to be arranged by CCMA. The cruise plan SOP from the RV Gyre had not been completed.
- 2.9. Sept 25 - Commenced sampling after regular 0700hrs Science Meeting. Sampled stations 1.17-1.12. Steamed SE overnight to deep water to attempt calibration of USBL before sampling off the edge of the shelf.

. The UAC wants to change cruise objectives to do mid-shelf water sampling. This is not practical as the ship does not have the proper equipment or supplies for water sampling, space for additional people to do it, time to do both water and sediment

sampling, and we were already beyond the mid-shelf area. The cruise plan SOP from the RV Gyre had not been completed.

- 2.10. Sept 26 – Began USBL calibration operations at 0500hrs. Calibration takes until 1900. Returned to sampling transect #1 during the night. The cruise plan SOP from the RV Gyre had not been completed.

- 2.11. Sept 27 – Commenced sampling 0715hrs at station 1.11, including a CTD cast. Sampled stations 1.11-1.5. Brown floc layer on surface of sediment cores becoming more noticeable. The cruise plan SOP from the RV Gyre had not been completed.

- 2.12. Sept 28 – Commenced sampling 0700hrs at station 1.4, including a CTD cast. Sampled stations 1.4-1.1 and 0.0 (approximately 500m west of the well head). Floc thickness increases toward well head site. Floc has no odor, but smears down sides of sample tubes and releases sheen on the water at some (not all) locations (Fig 5).

The UAC wants to change cruise objectives again. BP objects to doing benthic invertebrates on shelf samples. They want to switch sampling gear to Van Veen grab samplers and only want to do chemistry and Microtox analysis on the shelf, but continue using the multicorer in deep water. A partial draft SOP for the multicorer operation on board the Ocean Veritas based on the Gyre cruise plan is delivered. Steamed to Port Fourchon during the night for routine resupply and sample shipping.

- 2.13. Sept 29 – Arrive at Port Fourchon 0800. Supplies ordered through CCMA arrive. Partial crew change for deck operations. Brian Critchley returns to New Orleans to assume new duties. Final GC/MS components and fresh Microtox cultures are delivered. Analysis of backlogged samples are immediately begun. Entrix refuses to catalog or ship biota and toxicity samples. These samples are shipped by Shaw Grp. but are delivered late so the Microtox samples thawed, and the meiofauna samples were delivered to the wrong lab. Leave dock at 2000 and transit to transect 2.

- 2.14. Sept 30 – Commenced sampling at 0700hrs at station 2.30. Sampled 3 stations (2.30-2.28) before weather came up suddenly. Wind abated enough to sample station 2.24 before the end of deck crew shift.

The UAC wants to change cruise objectives again. Now BP wants to abandon the transects altogether and sample a randomized set of stations in shallow, medium, and deep strata (Fig 6). Shallow shelf areas are to be sampled with box corers and/or Van Veen grabs, medium depth areas with box corers and the deep areas with multicorers. The NOAA SMU cannot confirm this change. There is not a box corer on board, so, I choose to continue to sample in the deep areas of the transects with the multicorer.

- 2.15. Oct. 1 – Commenced sampling 0700hrs at station 2.23. Completed transect #2 and began sampling away from the well head on transect #3. Deep stations require long deployment times to drop gear all the way to the bottom, so only five stations were completed. All samples have floc layers 1-4cm thick.

The UAC has changed the cruise objectives back to the original transect pattern for now. A new set of sampling locations are being negotiated and will be distributed over the weekend. BP has decided to stop all onboard analyses for both GC/MS and Microtox. The lab is to be dismantled immediately and removed from the ship at the earliest possible date.

- 2.16. Oct 2 – Commence sampling at 0700hrs at station 3.33. Sampled away from well head up transect #3 to edge of shelf at station 3.35. Moved over to transect #4 to station 4.49 and sampled back toward the well head. Completed seven stations. All samples have floc layers 1-4cm thick.

- 2.17. Oct 3 – BP has decided the ship will return to port for 2 days to remove the lab and chemists despite the fact the ship will return to port for routine resupply Tuesday night. The NOAA SMU cannot confirm this change. Winds suddenly come up, seas build to 8-10' and sampling operations are halted. Transited to Port Fourchon overnight. New sampling locations are not yet available from the UAC.
- 2.18. Oct 4 – Drove from Port Fourchon to Houma to ship frozen Microtox samples to Texas A&M lab. Lab facility is removed from ship including the Microtox unit. Entrix personnel refuse to ship archived GC/MS samples, collected for onboard analyses, to analytical lab. Will have to ship them separately to an alternate lab, but NOAA SMU cannot decide which. New sampling locations are not yet available from the UAC. Depart Port Fourchon 1900hrs.
- 2.19. Oct 5 – Returned to transect #4 to resume sampling, but weather was still too rough to sample until 1530hrs. Collected samples at stations 4.45 and 4.44. Floc on surface 1-3cm thick. Sample at 4.44 smells similar to kerosene. New sampling locations are not yet available from the UAC. Transit back to Port Fourchon for routine resupply.
- 2.20. Oct 6 – Arrive Port Fourchon 0800hrs. Shipped benthic infaunal samples to Texas A&M and Univ, Nevada via FedEx. Shipped excess gear to SSMC4 and backup samplers by freight. Partial ship's crew change. A new BP chief scientist (Dr. Claire Dalglish) comes aboard to learn the operation and run the next leg of the cruise starting Oct 9. Depart Port Fourchon 1200hrs and transit back to transect #2. New sampling locations arrive from the UAC via BP (Fig 7).
- 2.21. Oct 7 - Commence sampling at station 2.27 after 0700hrs science meeting. Completed final three stations on original transect #2 (2.27-2.25). Transited to station D057S on new list. This station was previously sampled by Univ. Ga. researchers. Floc layer 2-3cm deep, with sheen on water. Also sampled station D072S. Transited back to Port Fourchon for demobilization.
- 2.22. Oct 8 – Shipped final benthos and Microtox samples from this leg. Still no word on where the extra GC/MS should be shipped to from NOAA SMU. Dr. Dalglish will retain them until a determination is made. Met with replacement NOAA rep (Frank Coluccio) for orientation. Met with Capt. Perry, Dr. Dalglish, and Frank Coluccio to develop a strategy for the second leg.

3. Continuing Operations

- 3.1.1. Following demobilization additional deck crew members came aboard to increase the ship's complement to support 24hr operations. The second leg of the cruise then set out on Oct 9 to sample the new list of sites provided by UAC. Sampling continued through Oct 18, with an evolving set of target sampling locations. A third leg was initiated with an additional set of sites that lasted from Oct 20-Oct 24, with a final demobilization at Morgan City, LA. Daily reports from operations have been provided by the BP chief scientist, but only photographic records are available at the present time. Based on measurements from the first leg and photographs from the second leg, the incidence and depth of the floc layers on the sediment surface are illustrated in Figs 8 and 9.

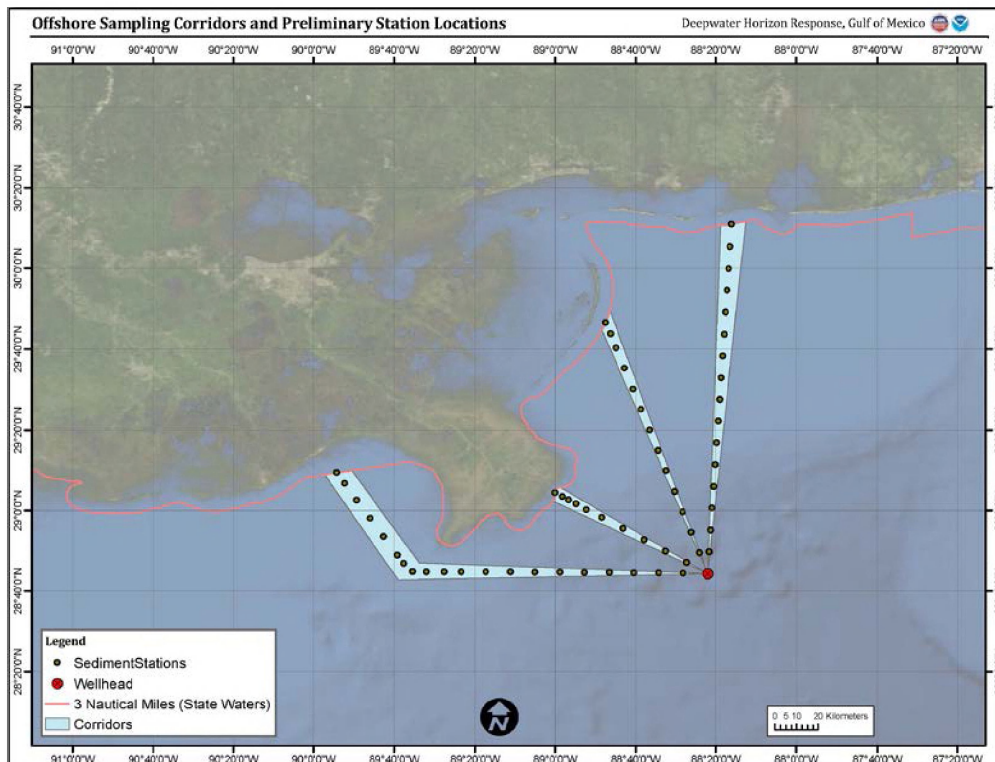


Figure 1. Proposed sampling corridors and locations.



Figure 2. Multicorer sampling device.

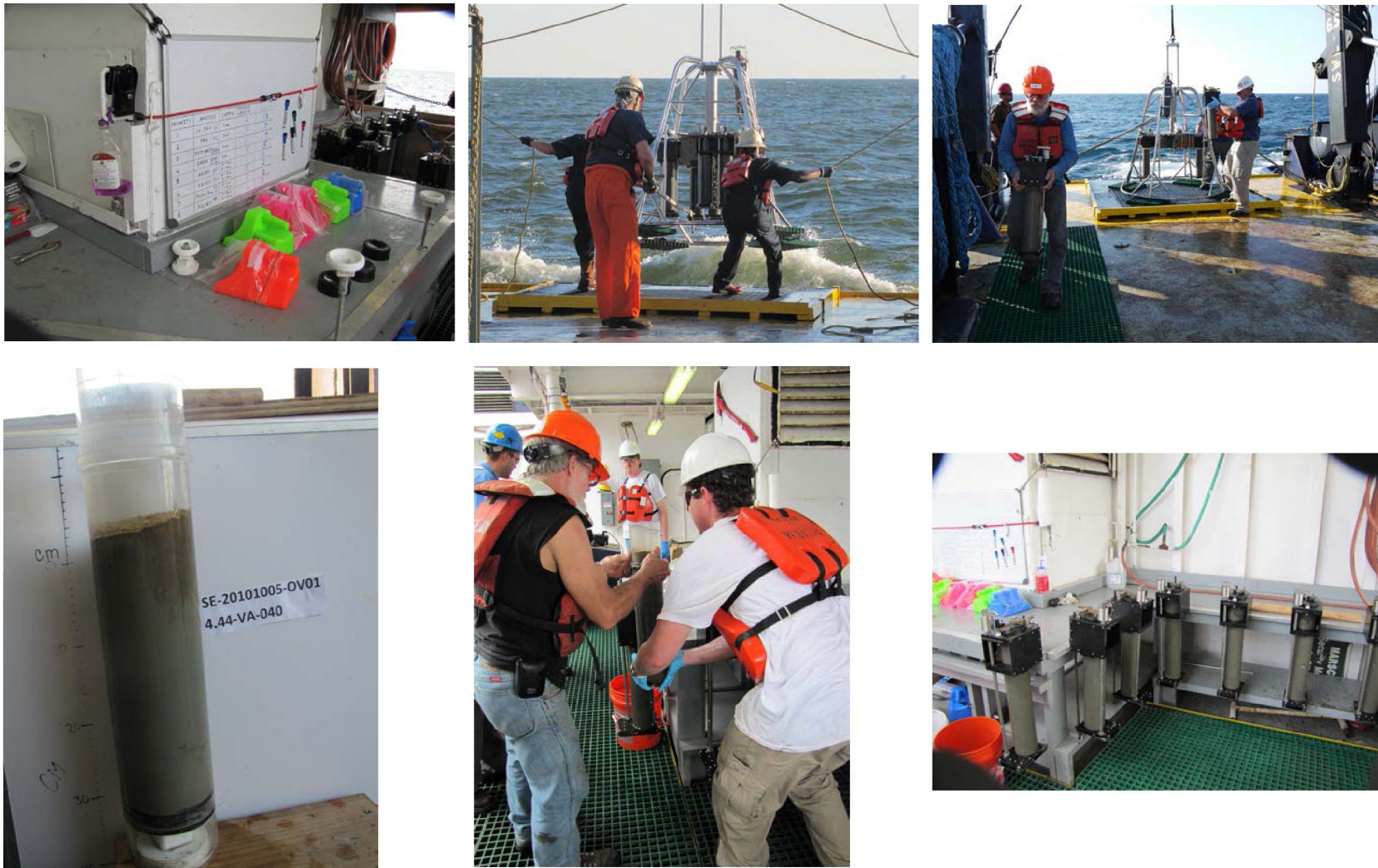


Figure 3. Sample collection operations. Clockwise from upper left; sample processing area prepped and clean, retrieving sampler, collecting cores, arranging cores in random sequence, removing core from housing, intact core.



Figure 4. Sample processing operations. Clockwise from upper left; extruding core, top surface of core, extruded sample, slicing top of core into scoop, intact macrofauna sample,.

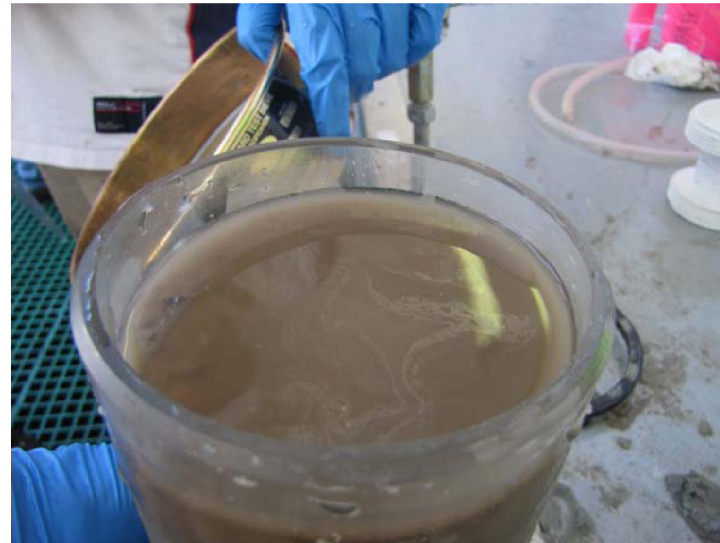


Figure 5. Examples of sediment samples. Above left; normal sediment with infauna bioturbation. Above right; presumably impacted sediment with surface floc – note undisturbed water column above sediment. Below; sheen on sample surface.

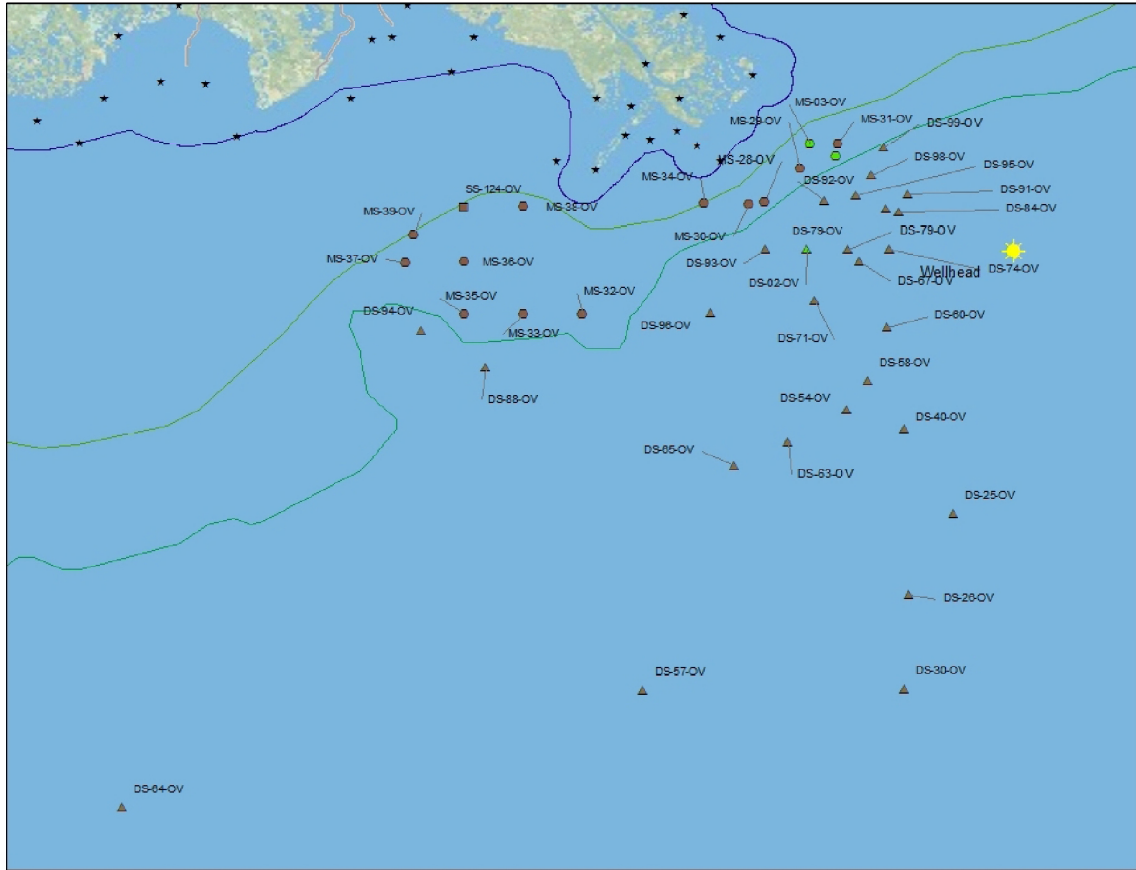


Figure 6. Proposed sampling stations to replace original transect plan.

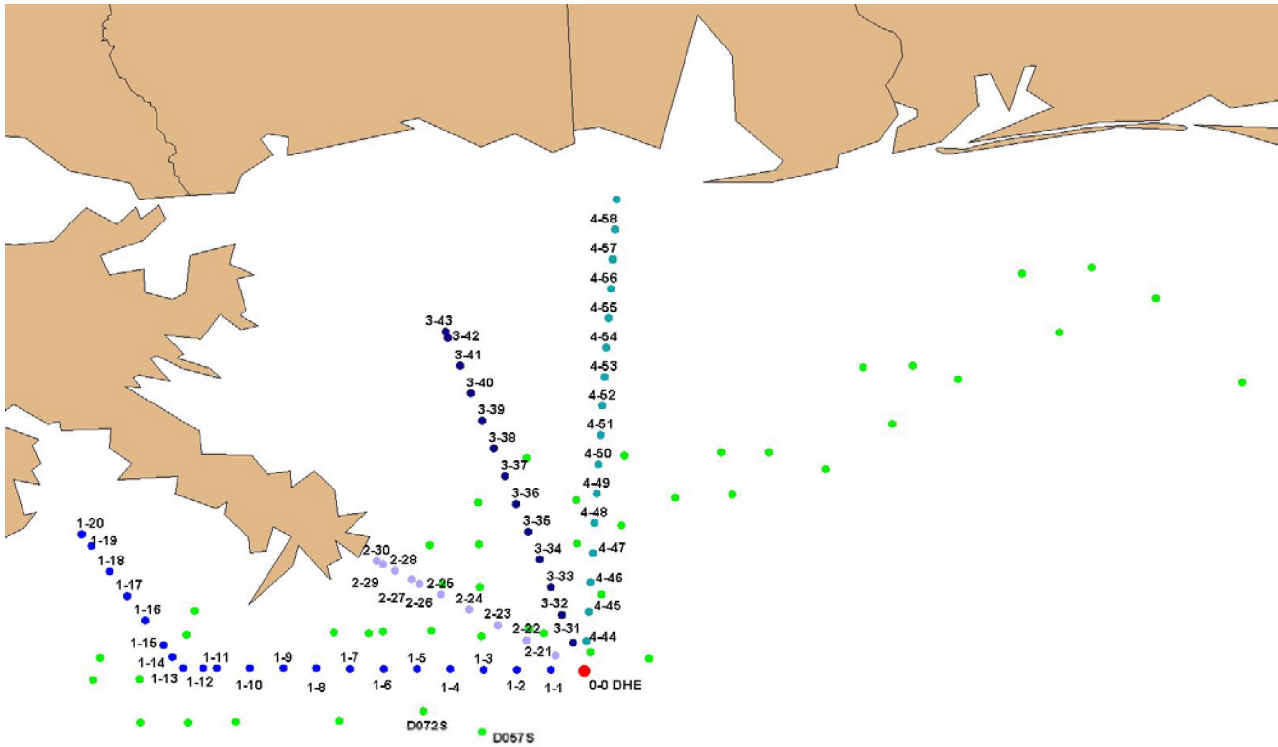


Figure 7. Sampling locations for leg 1 transects (blue) and leg 2 stations (green).

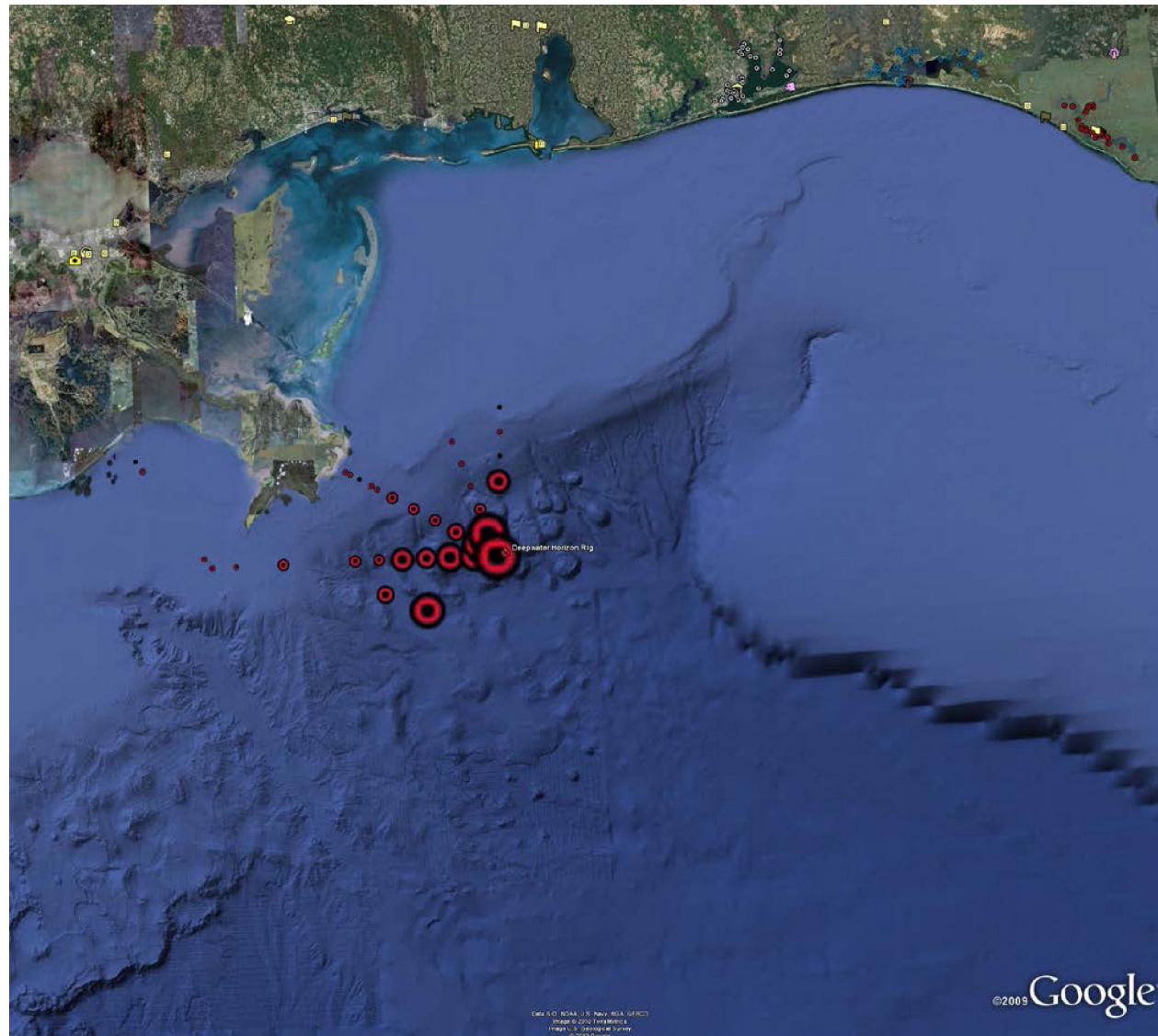


Figure 8 Depth of observed floc on sediment surface from samples on the first leg of the cruise. Floc depth ranges from 0-4cm.

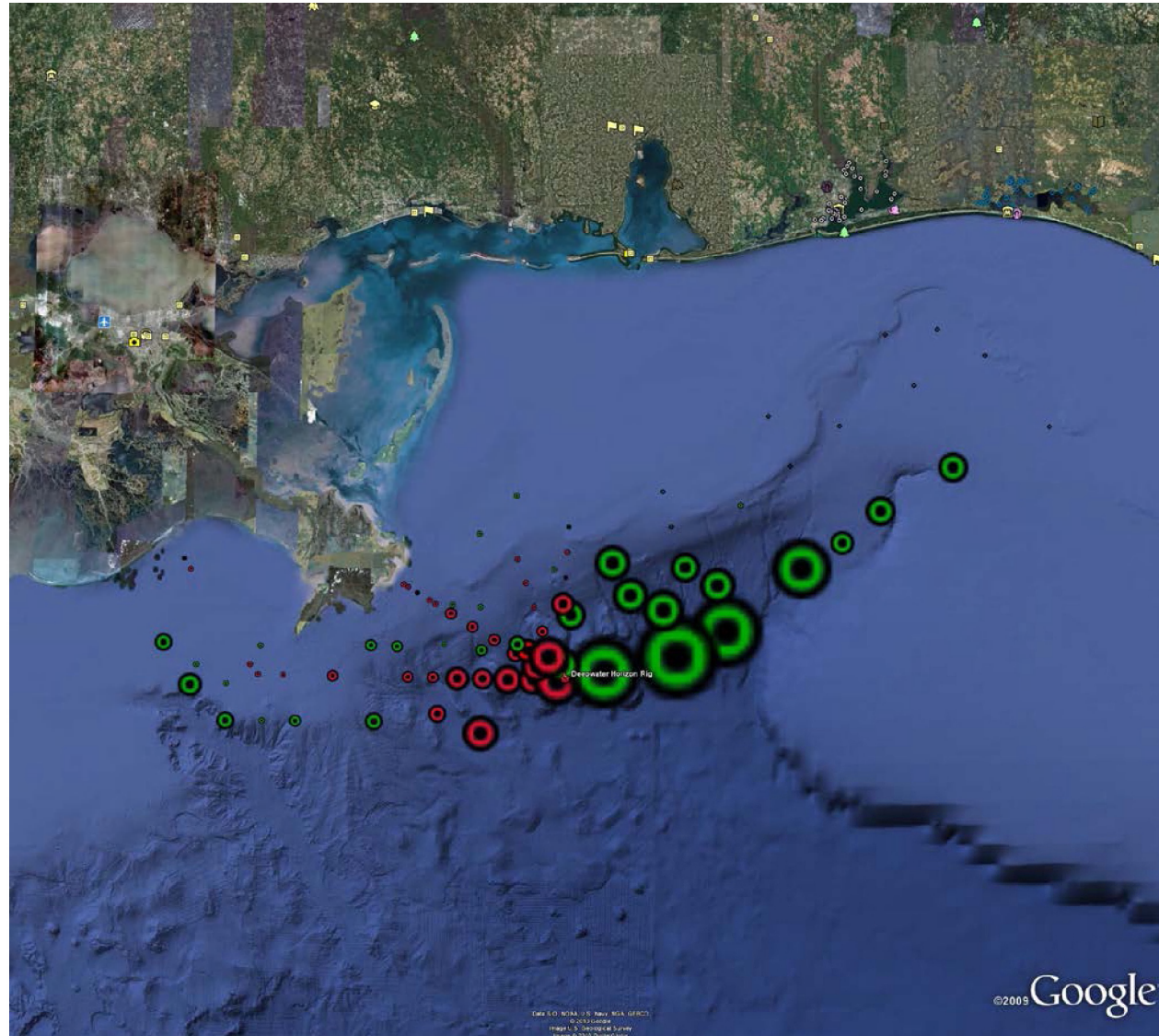


Figure 9 Depth of observed floc on sediment surface from samples on the first (red) and second (green) leg of the cruise. Floc depth ranges from 0-7cm.